International Journal of Agricultural Science and Research (IJASR)
ISSN(P): 2250-0057; ISSN(E): 2321-0087
Vol. 7, Issue 4, Aug 2017, 23-30

IMPACT OF STORAGE TEMPERATURE (7°C) AND POST-HARVEST PRE-TREATMENTS ON QUALITY CHARACTERISTICS AND STORAGE LIFE OF TOMATO (*LYCOPERSICONESCULENTUM)* FRUITS

G. MOHAN NAIK[1], R. F. SUTAR[2] & R. JAGAN MOHAN[3]

[1,3]*Indian Institute of Food Processing Technology, Thanjavur, Tamil Nadu, India*

[2]*College of Food Processing Technology and Bio-Energy, AAU, Anand, Gujarat, India*

ABSTRACT

Temperature has a remarkable effect on the rate of metabolic processes and quality characteristics of fruits and vegetables. Various post-harvest and pre-harvest treatments are applied to fruits and vegetables in order to extend the shelf life and preserve the quality characteristics for the longer duration of time. Each methods has their own advantages and limits. The present study was carried out with an objective to evaluate the impact of storage temperature and post-harvest treatments like edible coating, pre-cooling and combination of these on storage life and quality characteristic tomato fruit. Pre-treated fruits were stored at 7°C and evaluate the quality parameters like physiological weight loss (PLW), pH, TSS, titratable acidity, lycopene content and percentage of spoilage at the interval of three days during storage. It was noticed that increase in PLW (4.52%), TSS (3.7 box), lycopene content (1.67 mg/100g), percentage of spoilage (15.55%) and decrease in pH (4.0), titratable acidity (0.29 % citric acid) was noticed at the end of shelf life. All treated samples shows little resistance to chilling injury compared to control samples. Sample T3C0 (Hydro-cooling at 8 °C + without coating) have 18 days storage life with minimum spoilage. The activity of edible coating was reduced due to the effect of storage temperature, at this condition coating lose its stability and easily separated from the product. It can be concluded that post-harvest treatments play important role in order to extend the shelf life due to the effect of low temperature storage (7°C) fruits are very susceptible to chilling injury and spoiled rapidly.

KEYWORDS: ***Temperature, Post-Harvest, Pre-Harvest, Shelf Life & Chilling Injury***

Received: May 29, 2017; **Accepted**: Jun 22, 2017; **Published**: Jun 24, 2017; **Paper Id.**: IJASRAUG20174

Original Article

INTRODUCTION

Tomato is the second most important crop in the world next to the potato. Fruits are frequently harvested at the mature green stage to minimize the losses during handling, processing and storage. Tomatoes are a good source of potassium, iron, phosphorus, vitamins C, E, B, and dietary fiber. Ripe tomatoes are red in color because lycopene pigment, an antioxidant (Kucuk*et al.*, 2002). Generally, fruits and vegetables are highly perishable commodities and deteriorate very quickly hence, that require to be handled with care to minimize losses. Due to improper storage and handling postharvest losses range from 20-50 percent in developing countries (Kader, 1992). During off-seasons when horticultural crops arrive in plenty at the market, prices slump is bringing the farmer less profit. These post-harvest losses can be minimized by using various post-harvest and pre-harvest technologies through proper handling, processing and storage.

Fruits and vegetables can be prolonged by low-temperature storage, it mainly reduces the respiratory metabolism, biochemical changes, microbial development and hence extending their shelf life (Wills et al., 1998).

Storage temperatures ranged from 10-15°C and 85-95% relative humidity could extend the postharvest life of fruits. Chilling injury and ripening rate are minimal at these temperatures.

Pre-cooling is the method followed to remove the field heat from freshly harvested fruits and vegetables. Considerably metabolic activity and consequently respiration rate and ethylene production of the fruits were reduced. Hydro-cooling is a procedure in which, fruits are either sprayed with or immersed in cold water to reduce their temperature/field heat. In hydro-cooling treatment, water is not lost from produce surfaces, but rather absorbed by them (Bartz 1988).

Edible coatings are thin layers of edible material (protein, carbohydrate, lipid based) applied to the product surface in addition to or as a replacement for natural protective waxy coatings and provide a barrier to moisture, oxygen and solute movement for the food. They are applied directly on the food surface by dipping, spraying or brushing to create a modified atmosphere (McHugh and Senesi, 2000)

Post-harvest treatments like pre-cooling, edible coating, MAP, CAS and low temperature storage plays a prominent role in order to increase the shelf life of the product as well as maintain good quality characteristics. The objectives of this study were to investigate the effects of storage temperature, pre-cooling and edible coating on quality characteristics and storage life of tomato fruit.

MATERIALS AND METHODS

Collection of Samples and Preparation

Breaker stage tomatoes (*cv*. Narendra-2) were freshly harvested from the local farmer's field and further washed with 500 ppm sodium hypochlorite solution for surface cleaning. Edible coating materials like corn starch, glycerol and oleic acid purchased from certified suppliers.

The edible coating emulsion was prepared by using three different level coating material, i.e. corn starch (2.5, 5.0 & 7.5%), glycerol 2% and oleic acid 2%. Coating emulsion was prepared by boiling the materials with the addition of distilled water. The coating was done by dipping the fruits in coating emulsion and keep it rested in 10-15 second in coating emulsion. Pre-cooling was done by using hydro-pre cooler with three different cooling medium temperature i.e. 4, 6 and 8^{o}C. A further study was carried out according to the treatment combination given below in Table 1. Treated samples were kept at a storage room temperature maintained 7^{o}C. At the interval of three days parameters like weight loss, percent spoilage, pH, tetra table acidity, total soluble solids, and lycopene content were examined throughout storage.

Table 1: Treatment Combinations

S. No.	Treatment Code	Description
1	T_0C_0	Without pre-cooling + without coating (Control)
2	T_0C_1	Without pre-cooling **+(**Corn starch 2.5% (W/V) + Glycerol 2% (V/V)+ Oleic acid 2% (V/V) +Distilled water for balance**)**
3	T_0C_2	Without pre-cooling + **(**Corn starch 5% (W/V) + Glycerol 2% (V/V) + Oleic acid 2% (V/V) + Distilled water for balance**)**
4	T_0C_3	Without pre-cooling + **(**Corn starch 7.5% (W/V) + Glycerol 2% (V/V) + Oleic acid 2% (V/V) + Distilled water for balance**)**
5	T_1C_0	Hydro-cooling at 4 °C + Without coating

Table 1: Con'td		
6	T_1C_1	Hydro-cooling at 4 °C + **(**Corn starch 2.5% (W/V) + Glycerol 2% (V/V)+ Oleic acid 2% (V/V) + Distilled water for balance**)**
7	T_1C_2	Hydro-cooling at 4 °C + **(**Corn starch 5% (W/V) + Glycerol 2% (V/V) + Oleic acid 2% (V/V) + Distilled water for balance**)**
8	T_1C_3	Hydro-cooling at 4 °C + **(**Corn starch 7.5% (W/V) + Glycerol 2% (V/V) + Oleic acid 2% (V/V) + Distilled water for balance**)**
9	T_2C_0	(Hydro-cooling at 6 °C + Without coating)
10	T_2C_1	Hydro-cooling at 6 °C + **(**Corn starch 2.5% (W/V) + Glycerol 2% (V/V)+ Oleic acid 2% (V/V) + Distilled water for balance**)**
11	T_2C_2	(Hydro-cooling at 6 °C + **(**Corn starch 5% (W/V) + Glycerol 2% (V/V) + Oleic acid 2% (V/V) + Distilled water for balance **)**
12	T_2C_3	Hydro-cooling at 6 °C + **(**Corn starch 7.5% (W/V) + Glycerol 2% (V/V) + Oleic acid 2% (V/V) + Distilled water for balance**)**
13	T_3C_0	Hydro-cooling at 8 °C + without coating
14	T_3C_1	Hydro-cooling at 8 °C + **(**Corn starch 2.5% (W/V) + Glycerol 2% (V/V)+ Oleic acid 2% (V/V) + Distilled water for balance
15	T_3C_2	Hydro-cooling at 8 °C + **(**Corn starch 5% (W/V) + Glycerol 2% (V/V) + Oleic acid 2% (V/V) + Distilled water for balance**)**
16	T_3C_3	Hydro-cooling at 8 °C + **(**Corn starch 7.5% (W/V) + Glycerol 2% (V/V) + Oleic acid 2% (V/V) + Distilled water for balance**)**

Physiological Weight Loss (PLW)

The weight loss of the tomato fruit sample was calculated by differences between initial weight and final weight divided by initial weight.

$$\text{PLW (\%)} = \frac{\text{Initial Weight} - \text{Final Weight}}{\text{Initial Weight}} \times 100$$

PH & TSS

$_P$H was measured by using a digital pH meter and TSS by using an PAL-1 handheld refractometer (ATAGO, Japan) at temperature of 20°C.

Titra Table Acidity

The titra table acidity of the sample was determined by the method described by Rangana (1986).

Lycopene Content

Lycopene was extracted and analysed according to Thimmaih (1999). The lycopene content (mg/100g) was calculated using molar extinction coefficient Σ = 17.2 X 10^{-4} $M^{-1}cm^{-1}$.

$$\text{Lycopene}\left(\frac{\text{mg}}{100}\text{g}\right) - \frac{3.1206 \times OD\ of\ sample \times Volume\ made\ up \times Dilultion}{\text{Weight of sample} \times 1000} \times 100$$

Spoilage (%)

Spoilage or rotting was determined by the visual observation, i.e. When 40 percent of fruits showed symptoms of spoilage, the fruits were considered to have reached the end of the shelf life (Rai*et al.*, 2012).

Statistical Analysis

Done by using completely randomized design (CRD). The critical difference value at 5% level of probability was used for comparison among treatment means.

RESULTS AND DISCUSSIONS

Effect of Low Temperature and Post-Harvest Treatment on Physiological Loss in Weight (PLW %), pH, TSS, Titra table Acidity, Lycopene Content and Spoilage (%) of Tomato

The results of physiological loss in weight of tomato stored at the 7 OC for the various pre-treatments are depicted in Figure 1. It was observed that minimum weight loss was observed in treatment T_2C_3 (0.34%) and higher in T_3C_0 (4.52%). All the treatments were significantly different from treatment mean at the end of storage life. During storage it was observed that the combination of low temperature storage and post-harvest treatments greatly reduces the physiological loss in weight by inhibiting transpiration and respiration mechanism. Weight loss progressively increased with the increasing storage time. Our results are in agreement with Castro *et al.* (2006) who tested different storage temperatures and demonstrated that weight loss was proportional to the storage period and storage temperature.

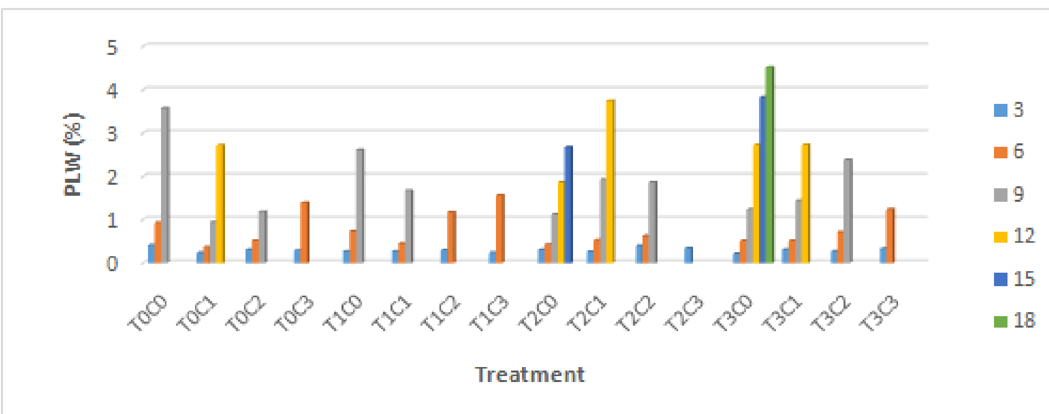

Figure 1: PLW (%) of Tomato Fruit Stored at 7 ^{O}c

The influence on pH by pre-treatment and storage temperature are depicted in Figure 2. It was observed that the pH of tomato increased throughout the shelf life. It was maximum in T_3C_1 (4.0) and minimum in T_1C_0 (3.57) followed by T_1C_2 (3.69). At the end of storage, it was found that all the treatment was founded significance during storage of tomato. It was noticed that the rate of increase in pH was low in case of at the 5 % level except T_0C_0, T_0C_1, T_1C_3, T_2C_1, T_2C_2 and T_3C_2. Rai*et al.* (2012) also reported similar results sample stored at low temperature storage.

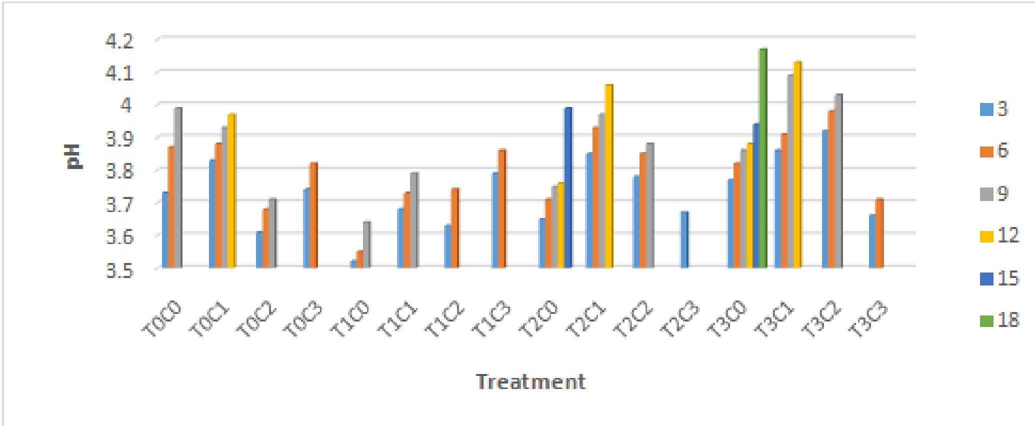

Figure 2: Changes in pH of Tomato Stored at 7 °C

Total soluble solids influenced by pre-treatments and 7°C storage temperature are depicted in Figure 3. Highest total soluble solids were found in T_0C_0 (3.70 °bx) where as lowest in T_1C_3 (3.31°bx) at the end of storage period. From the treatment mean it was found that all the treatment was at par at 5% significance level except T_0C_1, T_2C_2, T_2C_3 and T_3C_1 at the end of storage at 7°C. The total soluble solids increased during the ripening due to degradation of polysaccharides to simple sugars thereby causing a rise in TSS (Naik*et al.*, 1993). At the time of storage increase in TSS was found in all treatments. This result is in confirmation with the result of Bhaumik*et al.* (2015).

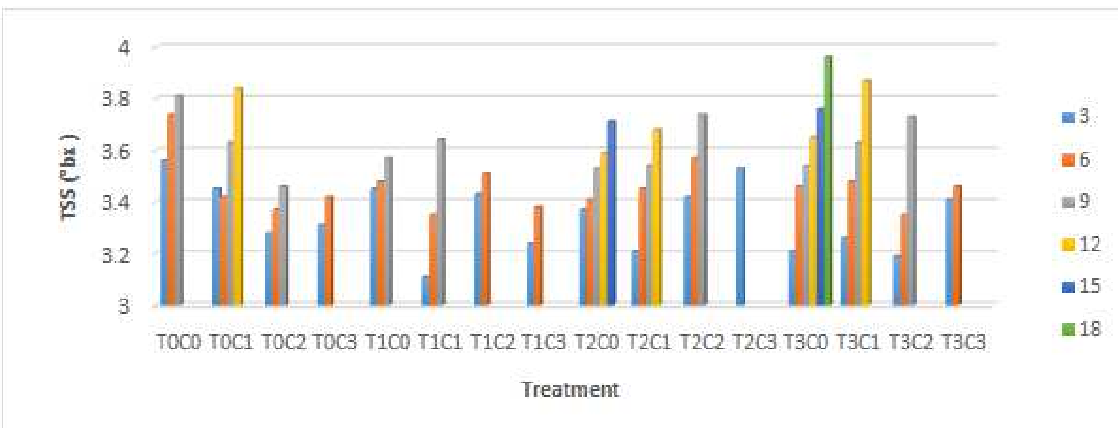

Figure 3: Changes in TSS of Tomato Fruits Stored at 7 °c

Influence on titratable acidity by pre-treatment and storage temperature are depicted in Figure 4. It was found that with the advancement of ripening and storage period acidity decreased. It was noted that titratable acidity was minimum in T_0C_1 (0.19) followed by T_0C_3 (0.19) and maximum in T_3C_3 (0.29) at the end of storage period. From the treatment, mean it was observed that all the treatments were significant at (P = 0.05) 5% level. The higher loss of titratable acidity during the storage time could be related to higher respiration rate as ripening advances where organic acids are used as substrate in respiration process (Lurie and Klein, 1990)

The data pertaining to the lycopene content of tomato for different pre-treatments and storage temperature are depicted in Figure 5. It was found that during advancement of ripening and storage period, the rate of synthesis of lycopene

content was slower. It was found that the lycopene content was maximum in T_3C_0 (1.67 mg/100g) and minimum in T_3C_3 (0.56 mg/100g). From the treatment, mean it was observed that all the treatments were significance at (P = 0.05) 5% level. Rai*et al.* (2012) stated that the increase in the level of lycopene during storage might be due to ripening advancements of tomato fruits and conversion of chloroplasts.

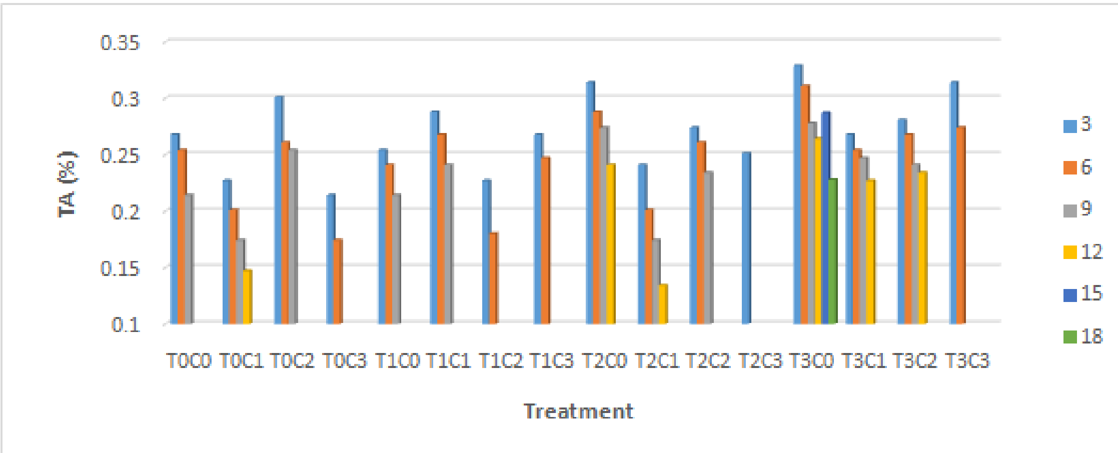

Figure 4: Changes in Titratable Acidity of Tomato Stored at 7 ^{O}c

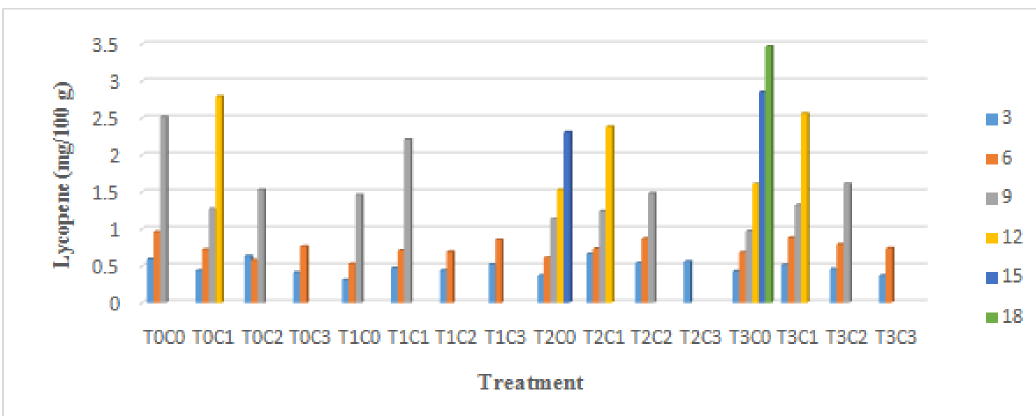

Figure 5: Changes in Bio-Synthesis of Lycopene Content of Tomato Stored at 7 ^{O}c

The spoilage of tomato stored at 7 ^{o}C for different pre-treatments are depicted in Figure 6. It was observed that the spoilage of tomatoes due to chilling injury is more common. It was highest in T_0C_0 (15.55%) followed by T_3C_1 (13.33%) and lowest in T_2C_3 (3.33%) followed by T_1C_0 (4.44%) at the end of storage period. From the treatment mean, it was found that all the treatments were significantly par at (P = 0.05) 5% level of significance except T_0C_2, T_1C_3, T_2C_0, T_2C_2, T_3C_0 and T_3C_1. It was observed that fruits were spoiled rapidly due to the effect of low temperature which cause chilling injury and make unacceptable. At this temperature coating material not with stand and easily peeled out and coating materials doesn't shows their activity to the expected level. Finally, this results is in agreement with the study of Castro (2006) which signifies that the temperature plays an important role in the spoilage of the fruits.

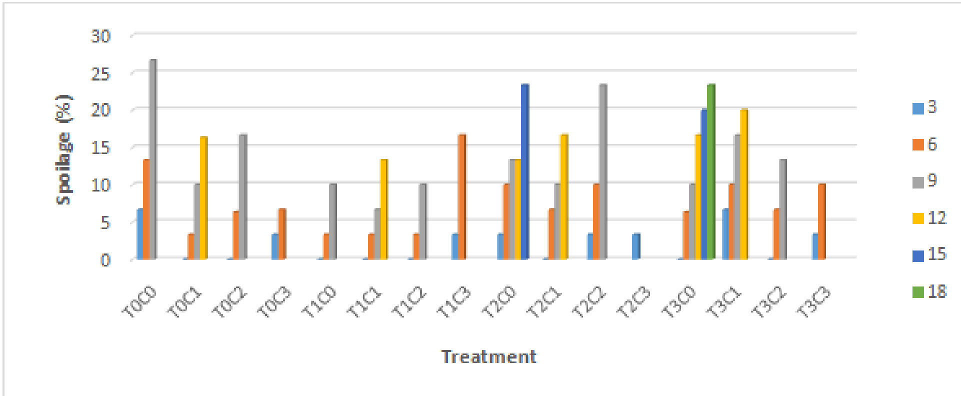

Figure 6: Spoilage of Tomato Stored at 7 ^{O}c

CONCLUSIONS

It would be concluded from the present study that quality characteristics and shelf life of tomato fruits varies with the treatment to treatments. During storage, control samples showed quick symptoms of chilling injury after three days of storage, while edible coated sample shows little resistance to chilling injury. The activity of edible coating on fruit quality directly depends on storage temperature. At low temperature (7^{o}C), edible coating is easily peeled out because of hygroscopic nature of corn starch; it would lose its film stability and integrity. Chilling injury is very common and this condition is not recommended to store the tomato fruits for a longer period of time.

ACKNOWLEDGEMENTS

Support from College of Food Processing Technology and Bio-Energy, and Department of Agricultural Statistics, B.A. College of Agriculture, Anand Agricultural University, gratefully acknowledged.

REFERENCES

1. *Ball, J.A. (1997). Evaluation of two lipid-based edible coatings for their ability to preserve post- harvest quality of green ball peppers. M. Sc. Thesis, Blacksburg, Virginia.*
2. *Bartz, J.A. (1988). Potential for postharvest disease in tomato fruit infiltrated with chlorinated water. Plant Disease. 72(1): 4-13.*
3. *Bhaumik, B. P., Sutar, R. F. and Sonali, C. K. (2015). Extension of shelf life of pre-cooled tomato fruit under refrigerated transport condition storage. Journal of Progressive Agriculture, 6(2): 118-124.*
4. *Castro, L. R. D., Cortez, L. A. B. and Vigneault, C. (2006). Effect of sorting, refrigeration and packaging on tomato shelf life. Journal of Food, Agriculture and Environment, 4: 70-74.*
5. *Kader, A. A. (1992). Postharvest Technology of Horticultural Crops, 2ndEdition, UC Publication. University of California, Division of Agriculture and Natural Resources, Oakland, California.*
6. *Kucuk, O., Sarkar, F. H., Djuric, Z., Sakr, W., Pollak, M. N. and Khachik, F. (2002). Effects of lycopene supplementation in patients with localized prostate cancer. Experimental Biology and Medicine, 227: 881-885.*
7. *Lurie, S. and Klein, J. D.(1990). Heat treatment of ripening apples: differential effects on physiology and biochemistry. Physiol. Plant. 78, 181–186.*

8. *McHugh, T.H., and Senesi, E. 2000. Apple wraps: A novel method to improve the quality and extend the shelf life of fresh-cut apples. Journal of Food Science 65(3): 480-485.*

9. *Naik, D. M., Mulekar, V. G., Chandel, C. G. and Kapse, B. M. (1993). Effect of pre-packaging on physico-chemical changes in tomato (LycopersiconesculentumMill.) during storage. Indian Food Packer, 12: 9-13.*

10. *Rai, G. K., Kumar, R., Singh, A. K., Rai, P. K., Rai, M., Chaturvedi, A. K. and Rai, A. B. (2012). Changes in antioxidant and phytochemical properties of tomato (LycopersiconesculentumMill.) under ambient condition. Pakistan Journal ofBotany, 44(2): 667-670.*

11. *Ranganna, S. (1986). Hand Book of Analysis and Quality Control for Fruits and Vegetable Products. Tata McGraw-Hill, New Delhi.*

12. *Thimmaiah, S. K. (1999). Standard Methods of Biochemical Analysis. Kalyani Publisher, New Delhi.*

13. *Wills, R., Mc Glasson, B., Graharn, D., and Joyce, D. (1998). "Postharvest. Introduction to the Physiology and Handling. Fruit, Vegetables and Ornamentals," 4/Ed. University of New South Wales, Sydney*